

Method and tester for determining an error rate of a mobile-telephone device with variable block assignment

5 The invention relates to a method and a tester for determining an error rate of a mobile-telephone device in the case of a data transfer with variable block assignment.

10 The basic structure of a known GSM mobile-telephone system, for example, as described in "Digital Mobile Telephone Systems", Dr.-Ing. Klaus David and Dr.-Ing. Thorsten Benkner, B. G. Teubner Stuttgart 1996, pages 326 to 341, is shown in much simplified form in Figure 5. In  
15 a mobile-telephone system of this kind structured according to the GSM standard, a mobile-telephone device, which is disposed, for example, in the motor vehicle 1 illustrated in Figure 5, communicates with a base station 2.

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In order to transmit information between the base station 2 and the mobile-telephone device, a downlink signal 3 is transmitted from the base station 2 to the mobile-telephone device, and an uplink signal 4 is transmitted  
25 back from the mobile-telephone device to the base station 2. To keep the downlink signal 3 and the uplink signal 4 separate from one another, both signals are transmitted with different carrier frequencies (FDD, Frequency Division Duplex).

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The transmission of information in the downlink signal 3 and in the uplink signal 4 does not take place in a continuous manner, but in so-called bursts, wherein, eight such bursts of a respective downlink signal 3 or

uplink signal 4 together form a frame. In Figure 5, a downlink frame of this kind is indicated by the reference number 5, and the corresponding uplink frame is indicated by the reference number 6, wherein each burst is

5 transmitted in a timeslot of a frame. The timeslots are numbered continuously from 0 to 7. The downlink frame 5 is transmitted with a first carrier frequency  $f_{1DL}$ , and the uplink frame 6 is transmitted with a corresponding carrier frequency  $f_{1UL}$ .

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The information is transmitted only in individual bursts of the respective downlink signal 3 or uplink signal 4. For this purpose, one or more given timeslots 0 to 7 of the frame are assigned by the base station 2 to the  
15 mobile-telephone device of the motor vehicle 1. Each timeslot 0 to 7 of successive downlink frames 5 and uplink frames 6 forms a transmission channel for the exchange of information between the base station 2 and the mobile-telephone device of the motor vehicle 1. For  
20 the first carrier frequency  $f_{1DL}$  and the corresponding carrier frequency  $f_{1UL}$  of the uplink signal 4, there are therefore eight transmission channels, so that eight mobile-telephone devices can exchange information with the base station 2 independently from one another on this  
25 pair of carrier frequencies.

In addition to the first carrier frequency  $f_{1DL}$  and the corresponding carrier frequency  $f_{1UL}$  for the uplink signal 4, further carrier frequencies are provided for the  
30 downlink signal 3, and carrier frequencies corresponding to these are provided for the uplink signal 4. As a result of the TDMA structure with its eight timeslots 0 to 7 in one frame, there are therefore eight transmission channels for each of the 124 carrier-frequency pairs in

the context of GSM 900 as illustrated in Figure 5,  
wherein all transmission channels are independent of one  
another. The eight transmission channels for each carrier  
frequency pair, together with the 124 independent carrier  
5 frequency pairs, therefore provide a total of 992  
transmission channels.

The use of one transmission channel simultaneously for  
several mobile-telephone devices to achieve an improved  
10 exploitation of the transmission capacity of a mobile  
telephone system of this kind is already known. Within a  
transmission channel, the mobile telephones are addressed  
by a base station, thereby specifying which of the  
several mobile-telephone devices receives data from the  
15 base station in which timeslots.

Corresponding timeslots of four successive frames of the  
downlink signal 3, or respectively the uplink signal 4,  
together form a transmission block of the respective  
20 transmission channel. For one respective transmission  
block, which is transmitted from the base station, it can  
be specified using an address signal ADR, to which of the  
mobile-telephone devices communicating with the base  
station in the same transmission channel the transmission  
25 block is transmitted from the base station.

Once again, in a much simplified form, Figure 6  
illustrates a system of this kind. A total of eight  
mobile-telephone devices 7, which jointly use one  
30 transmission channel in order to communicate with the  
base station 2, are shown. This means that a given  
timeslot of the downlink frame 5 and the uplink frame 6  
is used for the transmission of information between the  
mobile-telephone devices 7 and the base station 2. In

order to transmit data in a transmission block from the base station 2 to a given mobile-telephone device 8, an address signal ADR, which respectively addresses a given mobile-telephone device 8, is transmitted in each  
5 transmission block of the downlink signal 9. By evaluating the address signals ADR, the mobile-telephone device 8 recognises that the information contained in the transmission block is transmitted to this mobile-telephone device. The other mobile-telephone devices 7 do  
10 not recognise the address signal ADR as their own and reject the information of the transmission block. The base station 2 communicates to each mobile-telephone device 7, for example, at the time of establishing the connection, in which of the transmission blocks the  
15 mobile-telephone devices 7 actually evaluate an address signal ADR.

In this context, mobile telephones are all subscriber devices, which communicate with the base station 2. The  
20 correctness of the data of a transmission block received by the mobile-telephone device 8 is checked, for example, using a checksum. For each of the received transmission blocks, which were addressed to the mobile-telephone device 8, the base station 2 is notified on request,  
25 which transmission blocks were received and evaluated correctly. At the request of the base station 2, the mobile-telephone device 8 therefore transmits confirmation signals, for example, for each correctly-evaluated transmission block, a first marking "ack"  
30 (acknowledged), and for each incorrectly-evaluated transmission block, a second marking "nack" (not acknowledged). To achieve a correct communication of the complete information to the mobile-telephone device 8, each transmission block, for which the base station 2 has

received, for example, a second confirmation signal "nack", is re-transmitted.

- In developing mobile-telephone devices and in testing devices in production, it is necessary to determine the number of transmission blocks received and evaluated incorrectly and to compare these with the number of transmission blocks transmitted and/or addressed as a whole to this mobile-telephone device. With a given level and given propagation conditions, a permitted maximum threshold of ten per cent (10%) is provided in the specification, for example, for an EGPRS, for an error rate (BLER, Block Error Rate) determined in this manner.
- 15 The invention is based upon the object of providing a method and a tester for determining an error rate, with which the error rate for various requirements of the mobile-telephone device can be determined.
- 20 The object is achieved by the method according to the invention as specified in claim 1 and the tester according to the invention as specified in claim 9.
- To determine an error rate of a mobile-telephone device according to the invention, transmission blocks are transmitted to the mobile-telephone device in order to determine whether the mobile-telephone device has received and evaluated these transmission blocks correctly. The number of incorrectly-evaluated transmission blocks, which addressed the mobile-telephone device under test, is determined from the marking "ack" or "nack" transmitted back respectively, and the error rate of the mobile-telephone device is determined from this number.

In evaluating the data contained in a transmission block, the mobile-telephone device is subjected to a particularly large stress, if all of the transmission blocks transmitted contain an address signal ADR, which addresses the mobile-telephone device under test. The number of transmission blocks of a multiblock, which address the mobile-telephone device under test, is therefore specified according to the invention. In this context, a multiblock consists of a fixed number of successive transmission blocks of a transmission channel. As a result of this variable specification of the number of transmission blocks with an address signal ADR, which addresses the mobile-telephone device under test, the stress on the mobile-telephone device under test can be influenced in a targeted manner. For example, evaluations regarding an increase in the error rate with increasing stress are therefore also possible.

The dependent claims relate to advantageous further developments of the method according to the invention and the tester according to the invention.

The invention is described in detail in the description below with reference to the drawings. The drawings are as follows:

Figure 1 shows a schematic presentation of a signal transmitted from a base station to a mobile-telephone device,

Figure 2 shows a schematic presentation of several transmission blocks respectively in one transmission channel,

Figure 3 shows a simplified schematic presentation of a tester according to the invention,

5 Figure 4 shows examples for the addressing of a different number of transmission blocks of one multiblock in each case to the mobile-telephone device under test and their different arrangement,

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Figure 5 shows a schematic presentation of the transmission of information in a mobile telephone system according to the GSM standard, and

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Figure 6 shows a schematic presentation of the transmission of information between a base station and several mobile-telephone devices in one transmission channel.

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Figure 1 again illustrates the structure of a downlink signal by way of example. The entire signal consists of a concatenation of individual frames, wherein eight frames 9.1 to 9.8 are shown and wherein each frame 9.1 to 9.8 is further subdivided. The frames 9.1 to 9.8 are subdivided into timeslots, wherein eight respective timeslots together form one frame. The individual timeslots are numbered continuously from 0 to 7.

25 30 The smallest unit of information, which can be transmitted between the base station 2 and a mobile-telephone device, is formed by one transmission block. A transmission block of this kind consists respectively of one given timeslot in four successive frames. By way of

example, Figure 1 shows three examples of transmission blocks of this kind for the first four frames 9.1 to 9.4. A first transmission block 11.0 ( $B0_0$ ) is formed, for example, from the timeslots numbered 0 of the four frames  
 5 9.1 to 9.4.

A second transmission block 12.0 ( $B0_1$ ) is formed correspondingly by the timeslots with the number 1 in the same frames 9.1 to 9.4, while the third transmission  
 10 block 13.0 ( $B0_2$ ) shown in the diagram is formed by the timeslots with the number 2 in the frames 9.1 to 9.4.

Correspondingly, the three further transmission blocks  $B1_0$ ,  $B1_1$  and  $B1_2$  are formed by the frames 9.5, 9.6, 9.7  
 15 and 9.8 with the timeslots numbered 0, 1 and 2. As already explained in the introduction, corresponding timeslots of mutually successive frames 9.1 to 9.8 form a transmission channel, in which a mobile-telephone device communicates with a base station. Accordingly, the  
 20 illustrated example shows two respective, mutually-successive transmission blocks, 11.0 ( $B0_0$ ) and 11.1 ( $B1_0$ ) for a first transmission channel, 12.0 ( $B0_1$ ) and 12.1 ( $B1_1$ ) for a second transmission channel and 13.0 ( $B0_2$ ) and 13.1 ( $B1_2$ ) for a third transmission channel.

25 The communication between a mobile-telephone device and the base station 2 is therefore not restricted to a single transmission channel of this kind. On the contrary, in order to increase the quantity of data  
 30 transmissible between the mobile-telephone device and the base station 2, any number of timeslots 0 to 7 of the frames 9.1 to 9.8 can be used for communication between the mobile-telephone device and the base station 2. The number of timeslots 0 to 7, in which a mobile-telephone



device communicates with the base station 2 can therefore vary between one and all of the eight timeslots 0 to 7 of a frame.

- 5 For example, all three transmission channels illustrated in Figure 1 with the transmission blocks 11.0 and 11.1 of the first transmission channel, the transmission blocks 12.0 and 12.1 of the second transmission channel and the transmission blocks 13.0 and 13.1 of the third  
 10 transmission channel can be used for data transmission between the base station 2 and the mobile-telephone device.

- The further time course is shown schematically in Figure  
 15 2, wherein, by way of explanation, the three transmission channels, described with reference to Figure 1, are shown again as the first transmission channel 14, the second transmission channel 15 and the third transmission channel 16. The individual transmission blocks  $B0_0$  to  $B11_0$   
 20 of the first transmission channel 14 are indicated by the reference numbers 14.0, 14.1 etc. up to 14.11. Correspondingly, the individual transmission blocks  $B0_1$  to  $B11_1$  of the second transmission channel 15 are indicated by the reference numbers 15.0 to 15.11, and the  
 25 transmission blocks  $B0_2$  to  $B11_2$  of the third transmission channel 16 are indicated with the reference numbers 16.0 to 16.11.

- For each transmission channel 14, 15 and 16, the  
 30 illustrated twelve successive transmission blocks 14.0 to 14.11, 15.0 to 15.11 and 16.0 to 16.11 respectively form a multiblock of the corresponding transmission channel 14, 15 and 16. Each of the illustrated transmission blocks  $B0_1$  to  $B11_1$  is assigned to a given one of the

mobile-telephone devices 7 by means of an address signal ADR, which is transmitted in a header of the respective transmission block of the transmission blocks of the downlink signal 9 from the base station 2.

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To provide a measure for the quality of the data evaluation of a mobile-telephone device, the number of transmission blocks of the downlink signal incorrectly evaluated by the mobile-telephone device is determined.

10 For this purpose, the corresponding markings, which are transmitted back to the base station by the mobile-telephone device on request from the base station, are evaluated.

15 For example, with regard to transmission channel 14, the number of transmission blocks 14.0 to 14.11, in which the base station 2 transmits to the mobile-telephone device under test is specified according to the invention in a variable manner between only one of the transmission  
20 blocks 14.0 to 14.11 and a maximum of all twelve transmission blocks 14.0 to 14.11 of a multiblock of the transmission channel 14. Accordingly, the stress, to which the mobile-telephone device under test is subjected, can be influenced in a targeted manner.

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While only a slight stress to the mobile-telephone device under test is caused by isolated transmission blocks addressing the mobile-telephone device under test, because there is a considerable time interval between the  
30 individual evaluation algorithms to be implemented by the mobile-telephone device under test, the maximum stress is caused in the evaluation of the transmission blocks 14.0 to 14.11, when determining the error rate, for example,

of the first transmission channel 14, with the maximum of twelve transmission blocks 14.0 to 14.11.

By preference, the error rate is determined not only  
5 through the evaluation of the number of transmission  
blocks transmitted in the first transmission channel 14  
to the mobile-telephone device under test, but  
additionally with the use of several timeslots, that is  
to say, for example, by the additional use of the second  
10 transmission channel 15 and the third transmission  
channel 16 and by also transmitting transmission blocks  
addressed to the mobile-telephone device under test in  
these transmission channels. According to one preferred  
embodiment of the method according to the invention, the  
15 number of transmission channels used can also be adjusted  
in a variable manner between only one transmission  
channel and all of the transmission channels determined  
by the timeslots of the frame. In the example of a mobile  
telephone system provided in the introduction, there are  
20 eight transmission channels for the respective eight  
timeslots 0 to 7 of the frame.

In this context, the number of transmission blocks, which  
address the mobile-telephone device under test, can be  
25 specified separately for the individual transmission  
channels used. The specification of the transmission  
channels, in which a communication takes place between  
the base station 2 and the mobile-telephone device 8, is  
preferably implemented at the time of establishing the  
30 connection. For example, if more transmission blocks are  
used for the transmission of data from the base station 2  
to the mobile-telephone device 8 in order to increase the  
data rate, a new agreement regarding the transmission  
channels is made between the mobile-telephone device 8

and the base station 2, which then applies until further instructions.

By way of example, Figure 4 shows a mobile-telephone  
5 device, for which the error rate is to be determined, in  
communication with a base station 2 or respectively with  
a tester emulating a base station, in four transmission  
channels, which are represented respectively by a  
multiblock 20, 21, 22 and 23. The schematic structure of  
10 a tester of this kind according to the invention is  
described below with reference to Figure 3. While, in the  
first two transmission channels 20 and 21, which are  
marked with the index "0" and respectively "1" in the  
individual transmission blocks  $B0_1$  to  $B0_{11}$ , four  
15 transmission blocks respectively are transmitted to the  
mobile-telephone device under test 8, in other words,  
these transmission blocks contain a corresponding address  
signal ADR in the header, the transmission channels with  
the index "2" and respectively "3" contain three or  
20 respectively five transmission blocks, which address the  
mobile-telephone device under test. The transmission  
blocks, in which data are transmitted from the base  
station 2 to the mobile-telephone device under test, are  
indicated with an arrow.

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The other transmission blocks can preferably contain  
dummy data, for example, a predetermined data record  
without information content. In this context, the  
association of four timeslots to form one transmission  
30 block can also be cancelled. For the transmission blocks,  
which do not address the mobile-telephone device under  
test, any measures are permissible in principle, provided  
it can be ensured that these transmission blocks do not  
transmit any information to the mobile-telephone device

under test. For example, it is also possible to transmit to another mobile-telephone device or to reduce the level.

5 Figure 4 also illustrates the possibility of using identical or different patterns for the arrangement of the transmission blocks addressed respectively to the mobile-telephone device under test in different transmission channels, also with an identical number of  
10 transmission blocks transmitted to the mobile-telephone device. For example, a uniform arrangement of the four transmission blocks transmitted to the mobile-telephone device under test can take place via the transmission blocks of a multiblock, as illustrated for the multiblock  
15 indicated with reference number 20.

However, the transmission blocks  $B_{01}$  to  $B_{11}$  of a second multiblock 21, which are transmitted to the mobile-telephone device, are distributed in an irregular manner.  
20 The arrangement within a multiblock can, for example, be purely random, thereby providing a statistical distribution, which reduces the probability of the occurrence of a systematic error in the implementation of the measurement.

25 For a third multiblock 22, a uniform distribution of the transmission blocks transmitted to the mobile-telephone device under test is once again illustrated, wherein the number of transmission blocks addressing the mobile-  
30 telephone device under test is reduced by comparison with the two multiblocks 20 and 21.

Similarly, the number and the arrangement of the transmission blocks in the multiblock of the individual

transmission channels can be selected to be the same for all multiblocks and transmission channels.

5 In particular, a different arrangement and mutually different numbers of transmission blocks, which address the mobile-telephone device under test, can also be specified for multiblocks of the same transmission channel disposed in time succession relative to one another. This is especially advantageous, if the  
10 determination of the error rate is to be defined for variable conditions of the mobile-telephone device.

A tester 25 according to the invention and an arrangement with a mobile-telephone device under test 1 are shown in  
15 a much simplified form in Figure 3. The tester 25 according to the invention comprises a transmitter/receiver device 26, which comprises a transmitter device 26.1 for the transmission of a downlink signal and a receiver device 26.2 for receiving  
20 an uplink signal transmitted by the mobile-telephone device under test 31 via its antenna 32. Data are transmitted between the mobile-telephone device 31 and the tester 25 either via the antennae 30, 32 or via a connecting cable.

25 Message signals, that is to say, including the confirmation signals "ack" and respectively "nack", which are transmitted by the mobile-telephone device under test 31, are received by the receiver device 26.2. The  
30 receiver device 26.2 is connected to an evaluation unit 27, which registers the number of correctly-evaluated or incorrectly-evaluated transmission blocks of the downlink signal. If only the number of correctly-evaluated transmission blocks is determined, the corresponding

number of incorrectly-evaluated transmission blocks can be calculated.

5 The evaluation unit 27 also comprises a computer unit, which is suitable for determining an error rate for the mobile-telephone device 31 from the number of incorrectly-evaluated transmission blocks.

10 The error rate determined in the evaluation unit 27 is then displayed on a display device 29. The display on this display device 29 can be provided either by displaying a numerical value or via a corresponding graphic display. Instead of the integrated display device 29, as shown by way of example in Figure 3, the output  
15 may, of course, also be provided on a screen, for example, of a connected computer system.

In order to specify the transmission blocks addressing the mobile-telephone device under test 31, a selection  
20 device 28 is also disposed in the tester 25 according to the invention. On the basis of the specifications set by an operator of the tester 25 according to the invention, the selection device 28 defines which transmission blocks of the downlink signal are transmitted via the antenna 30  
25 of the tester 25 or the connecting cable with an address signal ADR addressing the mobile-telephone device under test. In this context, it has already been explained with reference to Figure 4, that, for different transmission channels and/or for multiblocks transmitted successively,  
30 a different number of transmission blocks addressing the mobile-telephone device 31 under test, which can, moreover, be arranged differently within a multiblock, can be transmitted in each case.

The selection device 28 therefore comprises means 28.1, with which a respectively variable stress on the mobile-telephone device 31 can be generated. In the simplest case, a memory is provided for this purpose, in which a  
5 profile for the successively transmitted multiblocks is stored for each of the transmission channels used, which specifies the number and distribution of the transmission blocks, which are transmitted to the mobile-telephone device under test. In order to determine the number and  
10 the distribution of transmission blocks transmitted to the mobile-telephone device under test 31, the number and distribution of address signals ADR addressing the mobile-telephone device for the subsequent multiblocks could also conceivably be calculated from the preceding  
15 multiblocks by means of a routine in the selection device 28.

During the implementation of the method according to the invention for determining the error rate, it is also  
20 possible for the base station 2 or respectively the tester 25 used for the implementation and the mobile-telephone device under test to communicate with one another via a sudden-frequency-change process. In this case, the term "transmission channel" relates to the  
25 connection between the base station 2 and the mobile-telephone device under test including the sudden-frequency change. This means that the transmission channel is then continued with the new carrier frequency, and the specification of the number of transmission  
30 blocks, which addresses the mobile-telephone device under test, does not take the respective sudden-frequency change into consideration.